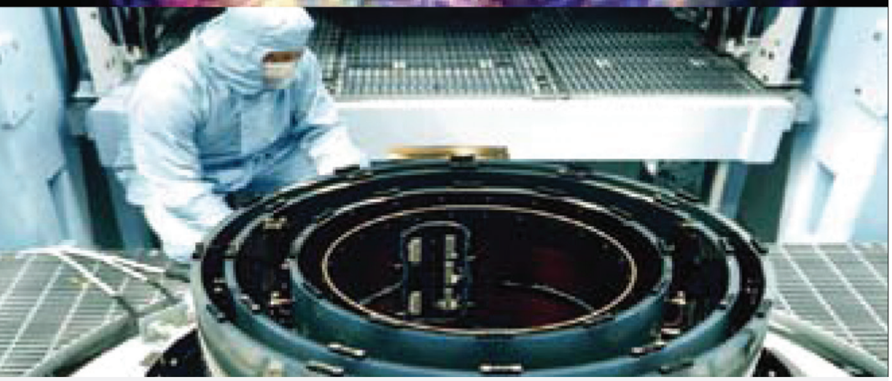


Optics

Electrochemically Enhanced Mechanical Polishing of Optics

Simultaneous figuring and polishing

NASA's Marshall Space Flight Center astrophysicists are developing better instruments to measure high-energy x-rays zipping about space when viewed from above the earth's atmosphere. Scientists at Marshall Space Flight Center (MSFC) adapted a novel method for material removal and superpolishing to the mandrel fabrication of an advanced x-ray telescope. The first MSFC application of Electrochemically Enhanced Mechanical Polishing (EEMP) involved producing mandrels for highly accurate cylindrical mirrors for the High Energy Replicated Optics (HERO) balloon-borne telescope. The new mandrel fabrication method, which replaces conventional mechanical figuring and polishing, resulted in a much more rapid and inexpensive production of the mandrel, with better control of the surface figure and surface quality during the process, and with a high degree of repeatability.

BENEFITS

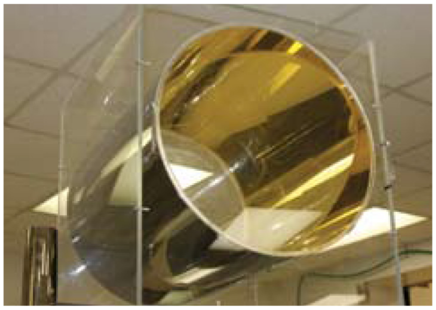
This technology offers various advantages over conventional mechanical polishing, plasma ion etching, and magnetorheological polishing:

- Faster material removal
- Reduced mechanical stress (print through)
- Capability to process multi-phase material
- Ability to handle large surfaces
- Lower capital cost
- Smaller equipment footprint
- Selective material removal
- Preserved surface microroughness, reducing need for additional polishing
- Deterministic approach

technology solution

THE TECHNOLOGY

Typically, mandrels are figured by mechanical grinding and polishing. MSFC scientists then use superpolishing techniques to produce finishes of a few Angstroms, which replicate directly to the surface of the mirror shell. Often the shape of the mandrel after basic figuring requires additional adjustments to remove a common characteristic known as mid-spatial-frequency ripple. This can dominate the optical performance of replicated shells but is very difficult and time consuming to remove. The EEMP technique was developed to remove these troublesome mm-to-cm-scale-length periodicities while maintaining surface finish. The EEMP method is computer controlled, coordinating all of the parameters that range from polishing media and electric current (which follows the profile of the material to be removed) to the position of the polishing lap. As long as the base material is conducting, semiconducting, or can be doped for conductance (such as silicon carbide), it is a candidate for EEMP surface treatment, even if it has multi-phase materials.



APPLICATIONS

The technology has several potential applications:

Astrophysics/Astronomy – lower-cost precision optics for telescopes

Search, surveillance, and detection – security devices can potentially be manufactured better, faster, and cheaper. Gregorian, Newtonian, and Cassegrain reflective optics can be cost-competitive with less capable refractive optics.

Optical components for UV solar blind detector – these components will now be both possible and affordable (e.g., long-range fire detection).

Military – lower-cost optics for weapons systems

High-quality, low-cost communications devices (terahertz, gigahertz, microwave)

Precision molds for pressing high-quality, inexpensive optical lenses

PUBLICATIONS

U.S. Patent No. 8,052,860

More Information

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